

Interphase Analysis and Control in Fiber Reinforced Thermoplastic Composites

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Abstract

The behavior of the fiber/matrix interface has been established as a critical issue in the performance of fiber reinforced composites. The goal of this research is to develop the science base underlying the formation and effects of transcrystalline regions in fiber reinforced thermoplastic composites. This understanding can then be used to control the interphase transcrystallinity for specific performance requirements, most notably in the automotive area where several mass production composite processes, such as the DRIFT and P4 processes, are being developed for thermoplastic composites.

The transcrystalline region is formed due to laterally restricted crystalline growth along the fiber, which has a significant nucleation density, in semi-crystalline polymer matrix systems. The polymer forms crystals during its solidification process, but the crystalline growth is a function of processing parameters, such as melt hold time, processing temperature, and the cooling rate of the polymer. Differential scanning calorimetry was used to observe and study the crystalline growth in a semi-crystalline polymer. Then, after introducing fibers into the system, the transcrystallinity was evaluated using a variety of analytical techniques.

To simulate the DRIFT manufacturing process, a technique to heat the carbon fibers has been developed to manufacture single fiber samples. This technique involves resistively heating the carbon fibers and applying a thermoplastic bead to the heated fiber. The single-fiber sample can then be evaluated for adhesion and wetting.